

What we claim is:

1. A subassembly for use in optical spectroscopy comprising:
  - a) an interferometer including optical components for receiving light and passing the light along a defined light path, the optical components including a beamsplitter separating the light into two portions and means for introducing a path length difference between the portions;
  - b) a vertical cavity surface emitting laser, including electronics to drive the vertical cavity surface emitting laser to project a beam therefrom, operatively mounted with the interferometer with a portion of the beam generally following the defined light path and a portion of the beam interacting with a defined response element and then to a detector, the vertical cavity surface emitting laser including an operating parameter control system for controlling an operating parameter of the vertical cavity surface emitting laser responsive to a signal from the detector.
2. A subassembly as in Claim 1, wherein the defined response element comprises an etalon.
3. A subassembly as in Claim 1, wherein the operating parameter control system controls the drive current to the vertical cavity surface emitting laser.
4. A subassembly as in Claim 1, wherein the operating parameter control system controls the temperature of the vertical cavity surface emitting laser.
5. A subassembly as in Claim 1, wherein the operating parameter control system controls the angle of propagation of the light emitted from the VCSEL.
6. A subassembly as in Claim 1, wherein the operating parameter control system controls an operating parameter of the vertical cavity surface emitting laser to establish a selected level of energy detected by the detector.
7. A subassembly as in Claim 1, wherein the operating parameter control system maintains the operating parameter at a first substantially stable level during an operating period, and establishes a second level that establishes a selected level of energy detected by the detector during a control period.
8. A subassembly as in Claim 1, wherein the defined response element has a maximum transmittance of energy having a desired wavelength, and wherein the operating parameter control system adjusts the operating parameter such that the energy detected by the detector is at a maximum and the output wavelength of the vertical cavity surface emitting laser is accordingly substantially at the desired wavelength.
9. A subassembly as in Claim 1, wherein the defined response element has a minimum reflectance of energy having a desired wavelength, and wherein the operating parameter control system adjusts the operating parameter such that the energy detected by the detector is at a minimum and the output wavelength of the vertical cavity surface emitting laser is accordingly substantially at the desired wavelength.
10. A subassembly as in Claim 1, wherein the vertical cavity surface emitting laser supplies a reference laser for the interferometer.

11. An optical spectrometer, comprising:
  - a) a vertical cavity surface emitting laser subsystem;
  - b) an interferometer, in optical communication with the vertical cavity surface emitting laser subsystem;
  - c) an etalon subsystem, mounted in an optical path from the vertical cavity surface emitting laser subsystem to the interferometer;
  - d) a detector, in optical communication with the interferometer;
  - e) a wavelength control processor, responsive to a signal from the detector and adapted to control an operating parameter of the vertical cavity surface emitting laser subsystem.
12. An optical spectrometer as in Claim 11, wherein:
  - a) the etalon subsystem comprises a temperature control system adapted to maintain a substantially constant operating temperature of the optical components of the etalon;
  - b) the vertical cavity surface emitting laser subsystem comprises a temperature control system adapted to maintain a substantially constant operating temperature of the vertical cavity surface emitting laser; and
  - c) the wavelength control processor comprises a variable current source connected to drive the vertical cavity surface emitting laser subsystem, and wherein the wavelength control processor controls the output of the variable current source.
13. An optical spectrometer, comprising:
  - a) a vertical cavity surface emitting laser subsystem, adapted to provide collimated output light;
  - b) an interferometer in optical communication with the vertical cavity surface emitting laser subsystem;
  - c) a detector in optical communication with the interferometer;
  - d) an etalon subsystem mounted in an optical path from the interferometer to the detector;
  - e) a wavelength control processor, responsive to a signal from the detector and adapted to control an operating parameter of the vertical cavity surface emitting laser subsystem.
14. An optical spectrometer according to Claim 13, wherein:
  - a) the etalon subsystem comprises a temperature control system adapted to maintain a substantially constant operating temperature of the optical components of the etalon;
  - b) the vertical cavity surface emitting laser subsystem comprises a temperature control system adapted to maintain a substantially constant operating temperature of the vertical cavity surface emitting laser; and
  - c) the wavelength control processor comprises a variable current source connected to drive the vertical cavity surface emitting laser subsystem, and wherein the wavelength control processor controls the output of the variable current source.
15. A subsystem generating output light for use with an optical spectrometer, comprising:
  - a) a vertical cavity surface emitting laser subsystem, adapted to provide collimated light;

- b) an auxiliary beam splitter in optical communication with the vertical cavity surface emitting laser, defining an output optical path and a feedback optical path;
- c) a detector receiving light along the feedback optical path;
- d) an etalon subsystem mounted in an optical path from the vertical cavity surface emitting laser subsystem to the detector;
- e) a wavelength control processor responsive to a signal from the detector and adapted to control an operating parameter of the vertical cavity surface emitting laser subsystem.

16. A subsystem according to Claim 15, wherein:

- a) the etalon subsystem comprises a temperature control system adapted to maintain a substantially constant operating temperature of the optical components of the etalon;
- b) the vertical cavity surface emitting laser subsystem comprises a temperature control system adapted to maintain a substantially constant operating temperature of the vertical cavity surface emitting laser; and
- c) the wavelength control processor comprises a variable current source connected to drive the vertical cavity surface emitting laser subsystem, and wherein the wavelength control processor controls the output of the variable current source.

17. An optical spectrometer, comprising:

- a) a vertical cavity surface emitting laser subsystem;
- b) an etalon having a transmission axis therethrough, in optical communication with the vertical cavity surface emitting laser subsystem and with the transmission axis oriented non-parallel with light from the vertical cavity surface emitting laser subsystem;
- c) a beam splitter in optical communication with the etalon, directing light from the etalon along first and second optical paths;
- d) a first detector in optical communication with the beam splitter along the first optical path;
- e) an interferometer in optical communication with the beam splitter along the second optical path, wherein light along the second optical path encounters the interferometer at an input port thereof, and wherein light exiting the interferometer via an exit port thereof does not encounter the beam splitter;
- f) a second detector in optical communication with the exit port of the interferometer;
- g) a wavelength control system, responsive to a signal from the first detector and adapted to control an operating parameter of the vertical cavity surface emitting laser subsystem.

18. An optical spectrometer as in Claim 17, wherein:

- a) the vertical cavity surface emitting laser subsystem comprises a lasing portion;
- b) the vertical cavity surface emitting laser subsystem comprises an aperture configured so that light returning to the vertical cavity surface emitting laser subsystem from the etalon is substantially prevented from reaching the lasing portion of the vertical cavity surface emitting laser subsystem by the aperture;

- c) the vertical cavity surface emitting laser subsystem comprises a temperature control system, adapted to maintain a substantially constant operating temperature of the lasing portion;
- d) the beam splitter comprises a substrate with a portion coated with a beam-splitting coating disposed in the path of light traveling from the etalon to the beam splitter;
- e) a portion of the substrate is coated with a reflective coating and is disposed in the path of light from the exit port of the interferometer such that such light is directed to the second detector.

19. An optical spectrometer, comprising:

- a) a vertical cavity surface emitting laser subsystem;
- b) an interferometer in optical communication with the vertical cavity surface emitting laser subsystem;
- c) an auxiliary beam splitter in an optical path from the vertical cavity surface emitting laser to the interferometer, defining a first optical path to the interferometer and a second optical path;
- d) an auxiliary detector in the second optical path;
- e) an etalon subsystem in an optical path from the vertical cavity surface emitting laser subsystem to the auxiliary detector;
- f) a wavelength control system, responsive to a signal from the auxiliary detector, adapted to modulate a drive current to the vertical cavity surface emitting laser subsystem, and adapted to control the drive current such that the optical energy passed through the etalon is substantially maximized.

20. An optical spectrometer as in Claim 19, wherein the wavelength control system is adapted to modulate the drive current to the VCSEL subsystem according to a modulation characteristic, and wherein the wavelength control system is adapted to demodulate the signal from the detector according to the modulation characteristic.

21. An optical spectrometer, comprising:

- a) a vertical cavity surface emitting laser subsystem;
- b) an interferometer in optical communication with the vertical cavity surface emitting laser subsystem;
- c) a detector in optical communication with an output port of the interferometer;
- d) an etalon subsystem in an optical path from the vertical cavity surface emitting laser subsystem to the detector;
- e) a wavelength control system, responsive to a signal from the detector, adapted to modulate a drive current to the vertical cavity surface emitting laser subsystem, and adapted to control the drive current such that the optical energy passed through the etalon is substantially maximized.

22. An optical spectrometer as in Claim 21, wherein the wavelength control system is adapted to modulate the drive current to the VCSEL subsystem according to a modulation characteristic, and wherein the wavelength control system is adapted to demodulate the signal from the detector according to the modulation characteristic.

23. A subassembly as in Claim 1, wherein the defined response element comprises an etalon chosen from the group consisting of:

- a) an optically transmissive substrate having two substantially parallel opposing surfaces, where each surface is partially reflecting;
- b) first and second plates, spaced apart and substantially parallel, where the first and second plates are substantially parallel;
- c) first and second plates, spaced apart and substantially parallel, where the first and second plates are substantially parallel and wherein the space between the plates is at a substantially constant pressure;
- d) first and second plates, spaced apart and substantially parallel, where the first and second plates are substantially parallel and wherein the space between the plates is filled with a material of substantially constant composition;
- e) an optically transmissive substrate having opposing partially reflecting surfaces, where the optical path length through the etalon encountered by light from the vertical cavity surface emitting laser is substantially the same for all paths through the etalon from the vertical cavity surface emitting laser;
- f) an etalon having a free spectral range smaller than the total range of vertical cavity surface emitting laser output wavelengths reachable by control of the operating parameter.

24. A method of providing a source of energy having a stable wavelength for optical spectroscopy, comprising:

- a) providing a VCSEL;
- b) providing a detector in optical communication with the VCSEL;
- c) providing a defined response element in a path from the VCSEL to the detector, where the defined response element has a minimum absorbance at a desired wavelength;
- d) adjusting the operating environment of the VCSEL to change the wavelength of the VCSEL output over a range including the desired wavelength,
- e) monitoring the energy received by the detector, and
- f) maintaining the operating environment of the VCSEL where the monitored energy is at a maximum.

25. A method as in Claim 24, wherein providing an etalon comprises providing an etalon chosen from the group consisting of:

- a) an optically transmissive substrate having two substantially parallel opposing surfaces, where each surface is partially reflecting;
- b) first and second plates, spaced apart and substantially parallel, where the first and second plates are substantially parallel;

- c) first and second plates, spaced apart and substantially parallel, where the first and second plates are substantially parallel and wherein the space between the plates is at a substantially constant pressure;
- d) first and second plates, spaced apart and substantially parallel, where the first and second plates are substantially parallel and wherein the space between the plates is filled with a material of substantially constant composition;
- e) an optically transmissive substrate having opposing partially reflecting surfaces, where the optical path length through the etalon encountered by light from the vertical cavity surface emitting laser is substantially the same for all paths through the etalon from the vertical cavity surface emitting laser;
- f) an etalon having a free spectral range smaller than the total range of vertical cavity surface emitting laser output wavelengths reachable by control of the operating parameter.

26. A method as in Claim 24, wherein adjusting the operating environment of the VCSEL comprises adjusting the operating temperature of the VCSEL, adjusting the drive current supplied to the VCSEL, or a combination thereof.

27. A light source, comprising:

- a) a multimode VCSEL, emitting light at a plurality of VCSEL wavelengths over a range of wavelengths;
- b) an etalon, in optical communication with the VCSEL, providing output light from transmission of light in a plurality of etalon passbands, where at least one of the VCSEL wavelengths is within at least one of the etalon passbands.

28. A light source as in Claim 27, wherein the VCSEL comprises means for adjusting the operation of the VCSEL such that the VCSEL wavelengths change.

29. A light source as in Claim 28, wherein adjusting the operation of the VCSEL comprises adjusting the operating temperature of the VCSEL, the drive current supplied to the VCSEL, or a combination thereof.

30. A light source as in Claim 27, wherein the etalon comprises means for adjusting the operation of the etalon such that the etalon passbands change.

31. A light source as in Claim 30, wherein adjusting the operation of the etalon comprises adjusting the operating temperature of the etalon, the angle of the etalon to light from the VCSEL, the pressure of a medium between reflective surfaces of the etalon, or a combination thereof.

32. A light source as in Claim 27, wherein the free spectral range of the etalon is larger than the range of VCSEL wavelengths.